

REMARKS

This is intended as a full and complete response to the Office Action dated September 8, 2003, having a shortened statutory period for response set to expire on December 8, 2003. Please reconsider the claims pending in the application for reasons discussed below. Claims 7, 9, 11, 12, 14, 16, 17, 19, 20, 22, 24, 25, 27, 28, and 30-38 are pending in the application and stand rejected. Claims 1 - 6 stand withdrawn by the Examiner as directed to a non-elected invention. In this response, please cancel claims 1-6 as claims drawn to a non-elected invention and please cancel claims 9, 16, 17, 24, 25, 30, 32, 33, 35, 36, and 38. Applicants reserve the right to prosecute the canceled claims in a continuation/divisional application. Also, in this response, please amend claims 7, 11, 12, 14, 19, 20, 22, 27, 28, 31, 34, and 37 and please add new claims 40-57. Reconsideration of the rejected claims is requested for reasons presented below.

Claims 27-28 stand objected to on grounds that the claims depend on a canceled claim. In this response, Applicants have amended claims 27-28 to depend on claim 22. As a consequence, Applicants respectfully submit that the objection has been obviated. Withdrawal of the objection is respectfully requested.

Claims 7, 9, 11, 12, 14, 16, 17, 19, 20, 22, 24, 25, 27, 28 and 30-38 stand rejected under 35 USC § 103(a) over *Cohen* (U.S. Patent 6,610,151) in view of *Kang et al.* (U.S. Patent 6,139,700) and *Wang et al.* (U.S. Patent 6,387,806). Applicants respectfully traverse this rejection.

Claims 7, 11, 12, 14, 19, 20, 31, and 34

In regards to claims 7, 11, 12, 14, 19, 20, 31, and 34, the rejection states that it would have been obvious to modify the device of *Cohen* with the teaching of *Kang et al.* to switch the barrier deposition chamber to an ALD chamber in order to have excellent coverage in the via. In addition, it would have been obvious to further modify the device of *Kang et al.* with the teaching of *Wang et al.* to provide 0.01 to 1 atomic percent of metal dopant in the Cu layer because 0.01 to 1 atomic percent is the suitable solid solubility of elements in Cu. Applicants respectfully traverse this rejection on grounds that the references, alone or in combination, do not teach, show, or suggest a system as claimed.

Cohen discloses two embodiments of forming a metal seed bi-layer over a barrier layer. In a first embodiment, the metal seed bi-layer consists of a first conformal seed layer 20 deposited on the barrier layer 18 and consists of a second non-conformal seed layer 22 deposited on the first conformal seed layer 20. (See, Figure 1; col. 6, Ins. 20-37.) The first conformal seed layer 20 is deposited by chemical vapor deposition or electroless deposition techniques while the second non-conformal seed layer 22 is deposited by physical vapor deposition. (See, Figure 1; col. 6, Ins. 20-37.) In a second embodiment, the metal seed bi-layer consists of a first non-conformal seed layer 126 deposited on the barrier layer 118 and consists of a second conformal seed layer 128 deposited on the conformal seed layer 126. (See, Figure 3; col. 8, ln. 4 to col. 9, ln. 17.) *Cohen* further discloses that each seed layer 20, 22, 126, 128 can be made of copper, silver, or alloys of copper and/or silver. (See, col. 7, Ins. 52-59; col. 9, Ins. 10-17.)

First, the references, alone or in combination, do not teach, show, or suggest a copper alloy seed layer comprising aluminum, magnesium, titanium, zirconium, tin or combinations thereof. The rejection combines *Cohen* with *Wang et al.* for the disclosure in *Wang et al.* of copper alloy seed layer containing zirconium. Applicants respectfully submit that the combination of *Cohen* and *Wang et al.* does not teach, show, or suggest a copper alloy seed layer comprising aluminum, magnesium, titanium, zirconium, tin or combinations thereof.

Wang et al. discloses a copper seed layer 214 of a first layer alloy comprising a first dopant having a solubility in copper greater than 0.09 percent. (See, Fig. 8; col. 6, Ins. 6-26.) The dopant can be silver or zinc. (See, col. 6, Ins. 6-26.) *Wang et al.* further discloses that the conductive fill material 216 (not the copper seed layer 214) comprises a second alloy of tantalum, calcium, cerium, and zirconium having a relating low solid solubility less than about 0.1 atomic percent within copper. (See, col. 6, ln. 54 to col. 7, ln. 4.) As a consequence, *Wang et al.* teaches away from a copper seed layer comprising zirconium. In addition, neither *Cohen et al.* nor *Wang et al.* teaches a copper alloy seed layer comprising an alloy metal of aluminum, magnesium, titanium, tin, or combinations thereof. Therefore, the combination of *Cohen et al.* and *Wang et al.* does not teach, show, or suggest a copper alloy seed layer comprising copper and a

metal selected from the group consisting of aluminum, magnesium, titanium, zirconium, tin, and combinations thereof. Withdrawal of the rejection is respectfully requested.

Second, the references, alone or in combination, do not teach, show, or suggest an atomic layer deposition barrier chamber for depositing a barrier layer comprising tantalum nitride. The rejection further combines *Cohen* with *Kang et al.* for the disclosure in *Kang et al.* of an atomic layer deposition chamber. Applicants respectfully submit that the combination of *Cohen* and *Kang et al.* does not teach, show, or suggest an atomic layer deposition barrier chamber for depositing a barrier layer comprising tantalum nitride.

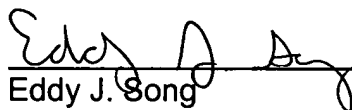
Kang et al. discloses an ALD-metal barrier layer forming chamber that is either an ALD-titanium nitride chamber or an ALD-tungsten nitride chamber. (See, col. 5, Ins. 4-8.) *Kang et al.* does not teach, show, or suggest an ALD-metal barrier layer that is an ALD-tantalum nitride chamber. There is no mention in *Kang et al.* of the deposition of tantalum nitride let alone atomic layer deposition of tantalum nitride. As a consequence, the combination of *Cohen* and *Kang et al.* does not teach, show, or suggest an atomic layer deposition barrier chamber for depositing a barrier layer comprising tantalum nitride. Withdrawal of the rejection is respectfully requested.

Claims 22, 27, 28, and 37

In regards to claims 22, 27, 28, and 37, the references, alone or in combination, do not teach show, or suggest a metal seed chamber for depositing a metal seed layer comprising a metal selected from the group consisting of aluminum, magnesium, titanium, zirconium, tin, or combinations thereof. *Cohen* discloses a chamber for depositing a copper and/or silver seed layer. (See, col. 7, Ins. 52-59; col. 9, Ins. 10-17.) *Wang et al.* discloses a copper/silver or a copper/zinc seed layer. (See, col. 6, Ins. 6-16.) *Kang et al.* does not disclose a seed layer material deposited over a barrier layer. As a consequence, the references, alone or in combination, do not teach show, or suggest a metal seed chamber for depositing a metal seed layer comprising a metal selected from the group consisting of aluminum, magnesium, titanium, zirconium, tin, or combinations thereof. In addition, the references, alone or in combination, do not teach, show, or suggest an atomic layer deposition barrier chamber for depositing a barrier layer comprising tantalum nitride. Withdrawal of the rejection is respectfully requested.

In conclusion, the references cited by the Examiner, alone or in combination, do not teach, show, or suggest the invention as claimed. Having addressed all issues set out in the office action, Applicant respectfully submits that the claims are in condition for allowance and respectfully request that the claims be allowed.

Respectfully submitted,



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